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Forecasting Research Division
Technical Report No. 223

Method for the representation of a verification of Terminal Aerodrome Forecasts (TAFs)

by

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October 1997

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0. INTRODUCTION

Terminal Aerodrome Forecasts (TAFs) are produced for all airports around the world. They provide details on the weather conditions that will occur at the airports, and any changes in weather that may occur during the TAF period.

Meteorological Actual Reports (METARs) are produced at airports every half an hour, and give the actual conditions at the airports.

TAFs play an important role in the decision as to whether an aircraft can land at its destination airport, or whether it will need to be diverted due to bad weather. Diverting an aircraft produces various costs to the airline. These occur from many factors, such as increase in fuel load, and transferring passengers back from the diversion airport, and so the airlines are keen to assess the accuracy of TAFs. Various different schemes assess TAFs[1], but they look at the overall statistics for long periods, and not individual TAFs.

An enquiry was made by a major airline as to whether the Meteorological Office could produce verification of individual TAFs. It was decided that a useful tool would be a program that could produce a plot of a TAF, and superimpose the actual observations (METARs) for the same period. Any enquiries about individual incidents would then have the benefit of clear and easily accessible information.

The most crucial information to the pilot is that of minimum visibility at the airport, and the lowest cloud base height. The program produced to assess TAFs looks at just these two elements, and produces plots of the TAF data, alongside the actual observations (METARs).

This report will explain how the raw data received from the observational database at the Meteorological Office (MetDB) for the airport and date specified by the user is used by two Fortran programs. The programs create four files of data that contain all the relevant information about either cloud base height or visibility for nine and eighteen hour TAFs. This output is then used by a spreadsheet package produced by Microsoft called EXCEL. A program written on this package produces a chart of each individual TAF produced on that date with the equivalent METARs for the same period. Direct comparison between the forecast and actual observation is then possible.

This document contains the following main headings:

0. INTRODUCTION

1. TAFS AND METARS

1.1 Example of a TAF

2. METHODOLOGY

2.1 Examples of charts

3. SUMMARY

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[1] Patton, R., Halsey, N., Lunnon, R.W., 1997: User sensitivity to ceiling and visibility and its influence on terminal forecast verification. 7th Conference on Aviation, Range and Aerospace Meteorology. Long Beach CA

1. TAFS AND METARS

TAFs and METARs are stored in raw report form in a database at the Meteorological Office (the MetDB). Pilots base their decisions as to whether an aircraft can land at an airport, on the minimum visibility and the lowest cloud base height. For this reason, much of the raw report can be ignored, and only certain elements are retrieved from the MetDB.

TAFs are written in a very specific format. As well as giving the main conditions for the TAF period, a forecaster must include any changes that will occur. The element *forecast change id* gives a description of how the changes will occur. The *id* 'BECMG' is used when the conditions will change over a period, and then these new conditions remain. The *id* 'TEMPO' is included when changes to overriding conditions will occur, but only temporarily during the TAF period. 'FM' (from) is used when there is a definite change to new conditions. Along with these definite *forecast change ids*, the forecaster is allowed to use a probability statement when the changes are not certain. A percentage is also given of either 30 or 40 percent. These uncertain *forecast change ids* can be combined with other conditions. For example, 'PROB 30 TEMPO' is used when there is a thirty percent chance that there will be a temporary change in conditions during the TAF period. The software used allows for retrieval of up to five changes.

Two different classifications of cloud base height can be retrieved, *deep convective cloud base height*, and *cloud base height* (any other type). In METARs, both classifications can be written for up to three layers of cloud, but the total number of levels cannot exceed three. For example, there could be two levels of *cloud* and one level of *deep convective cloud*, as there are three levels in total. For TAFs, only one layer of *deep convective cloud* is allowed, but up to three layers of any other type, again three levels in total.

The *cloud base amount* also needs to be retrieved for each cloud base. The different amounts that can be used are shown in Table 1 (each OKTA is one eighth of the sky coverage).

Table 1

Cloud Amount	Abbreviation	OKTAS
Few	FEW	0-1
Scattered	SCT	2-4
Broken	BKN	5-7
Overcast	OVC	8

Three different *general weather ids* contain information about the cloud base or visibility. These are CAVOK, SKC, and NSC. NSC (no significant cloud) is used for conditions where the cloud is above 5000 feet. SKC (sky clear) is used where there is no cloud at any level. CAVOK is used where the visibility is more than 10000m, no cloud below 5000 feet, and no cumulonimbus, precipitation, thunderstorm, shallow fog, or drifting snow.

1.1 Example of a TAF

EGKK 240110 VRB03KT CAVOK PROB30 TEMPO 0207 5000 BECMG 0608 BKN030 TEMPO 0810 8000 -RA

This TAF should be read as follows:

TAF for Gatwick (each airport has its own *ICAO id*, 'EG' stands for the UK, the next two letters are different for each airport), on the 24th of the month, between 0100 and 1000 hours. The next element is the wind, and is followed by the *general weather id* 'CAVOK', and hence no visibility or cloud is written in this section. Next is the first *forecast change id*, in this case indicating that there is a thirty percent chance that temporarily during the period between 0200 and 0700 hours, the visibility will fall to 5000m. The next *forecast change id* indicates that between 0600 and 0800 hours, there will be a change in the cloud base, and the new cloud base will be broken cloud at 3000 feet. This new cloud base will remain until the end of the TAF period. The last *forecast change id* indicates that temporarily during the period between 0800 and 1000 hours, the visibility will drop to 8000m, and there will be occasional rain.

2. METHODOLOGY

Once the input data of the date and airport of interest have been received, the relevant data is retrieved from the MetDB. Two separate Fortran programs are then run, one for cloud base height and one for visibility. The function of both Fortran programs is to read the data retrieved from the MetDB, and produce columns of data. The output has a column of times for every half an hour during the TAF period, and the METAR data for these times. There are two columns of TAF data, the definite predictions (including the *forecast change ids* 'FM' and 'BECMG') and the uncertain predictions (any *forecast change ids* with either 'PROB' or 'TEMPO'). This output can then be used by a spreadsheet package produced by Microsoft called EXCEL, to draw charts of each TAF that was produced on that date.

'TEMPO' has been included as uncertain as it only occurs temporarily during the TAF period. The uncertain TAF column just contains the worst condition in the TAF for that time, irrespective of what the *forecast change id* is. This is because when a pilot makes the decision on whether an aircraft will be able to land at a certain airport, the worst case conditions have to be read as definite values. 'BECMG' has been interpreted as implying a linear change from the old conditions to the new conditions, over the forecast change time. These assumptions are used in the verification scheme devised by Dr Gordon. See reference 1 for further details.

Both Fortran programs have to interpret the received MetDB data. The *general weather id* 'CAVOK' is changed to a visibility of more than 10000m, and a cloud base height of 6000 feet. 'SKC' and 'NSC' are both changed to cloud base heights of 6000 feet. The reason these interpretations are justifiable is that the axes on the charts are limited to values that are of relevance to large aircraft. These values are 10000m for the visibility charts, and 5000 feet for the cloud base height chart, and so these interpreted values do not actually appear on the charts. However, these interpretations are still made as they assist other calculations used in the programs. Each of the five possible changes is also assessed to see which contains the worst conditions for any one time, and this is used as the worst case condition. Another assumption made in the Fortran program for clouds is that a cloud amount of 'FEW' will not affect a flight, whatever height the cloud is. Therefore, if the lowest cloud base is 'FEW', it is ignored, and the next height is looked at.

With the four output files from the Fortran programs transferred across to the PC, and the spreadsheet package Excel opened, a single program can then be run to produce all the charts. It opens each of the four files in turn, and will produce one chart for visibility, and one chart for the

cloud base height, for each TAF that has been produced for the airport of interest on the specified date.

2.1 Examples of charts

The following is an example of an eighteen-hour TAF for Heathrow, on the eleventh of the month, between 1200 and 0600 the following day.

EGLL 111206 8000 FEW010 BKN020 BECMG 1922 3000 BKN015 BECMG 2224 5000 BKN 012 TEMPO 0006 2500 BKN 005 PROB30 TEMPO 0060 1500 BKN002

The visibility data can be read as follows.

Between 1200 and 0600, the minimum visibility will be 8000m, but will become 3000m between 1900 and 2200. The visibility will then become 5000m between 2200 and 2400. Temporarily between 0000 and 0600 the visibility will fall to 2500m, and there is a thirty percent chance that temporarily the visibility will fall to 1500m during the same period.

From figure 1, it can be seen that the main TAF line has been taken from the main visibility and the two BECMG statements. The TEMPO and PROB30 TEMPO statements are both considered as 'worse' statements, but as they both cover the same time period, only the shorter of the two distances is used, i.e. 1500m.

The cloud base data can be read as follows.

Between 1200 and 0600, there will be few clouds at 1000 feet, and broken clouds at 2000 feet. This will become broken cloud at 1500 feet between 1900 and 2200, and then this broken cloud will lower to 1200 between 2200 and 2400. Temporarily between 0000 and 0600 there will be broken cloud at 500 feet, and there is a thirty percent chance that temporarily between 0000 and 0600 there will be broken cloud at 200 feet.

From figure 2, it can be seen that the main TAF line begins at 2000 feet. This level is used instead of the cloud at 1000 feet, as there are only 'few' clouds at this level, and therefore not enough to cause problems for a pilot. The next layer of cloud is used instead. The rest of the main TAF line is taken from the BECMG data again, with the 'worst' line calculated from the TEMPO and PROB30 TEMPO data. Again, the lowest height is the only one that is printed as the times overlap.

The following example is one of the METARs for the same charts.

EGLL 11009KT 6000 BKN037 OVC050 01/M05 Q1015 NOSIG

The cloud base height is broken cloud at 3700 feet, and overcast cloud at 5000 feet. Only the lower of these two levels is plotted on the chart. The visibility data is given as 6000m. The other information in the METAR is for wind, temperature, pressure, and change in the next two hours, none of which is of any use to this program.

3. SUMMARY

Although some assumptions have been made in the interpretation of the TAFs and METARs, the majority of the basic data that a pilot would receive in a TAF is displayed in the charts. Assessment of individual TAFs is left to the user.

Figure 1

PLOT OF TAF FOR EGLL ON 11/03/1996 BETWEEN 1200 AND 0600

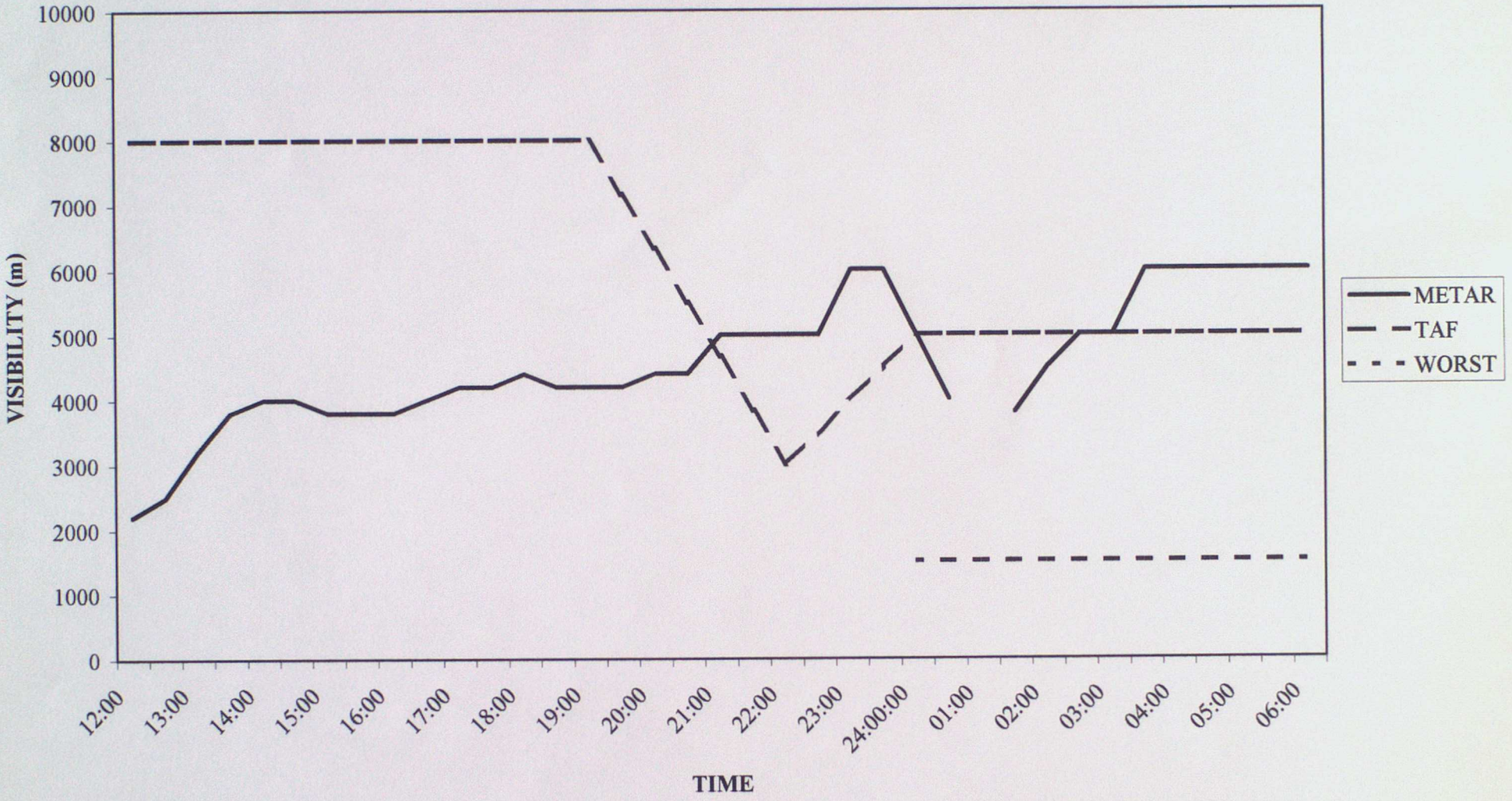
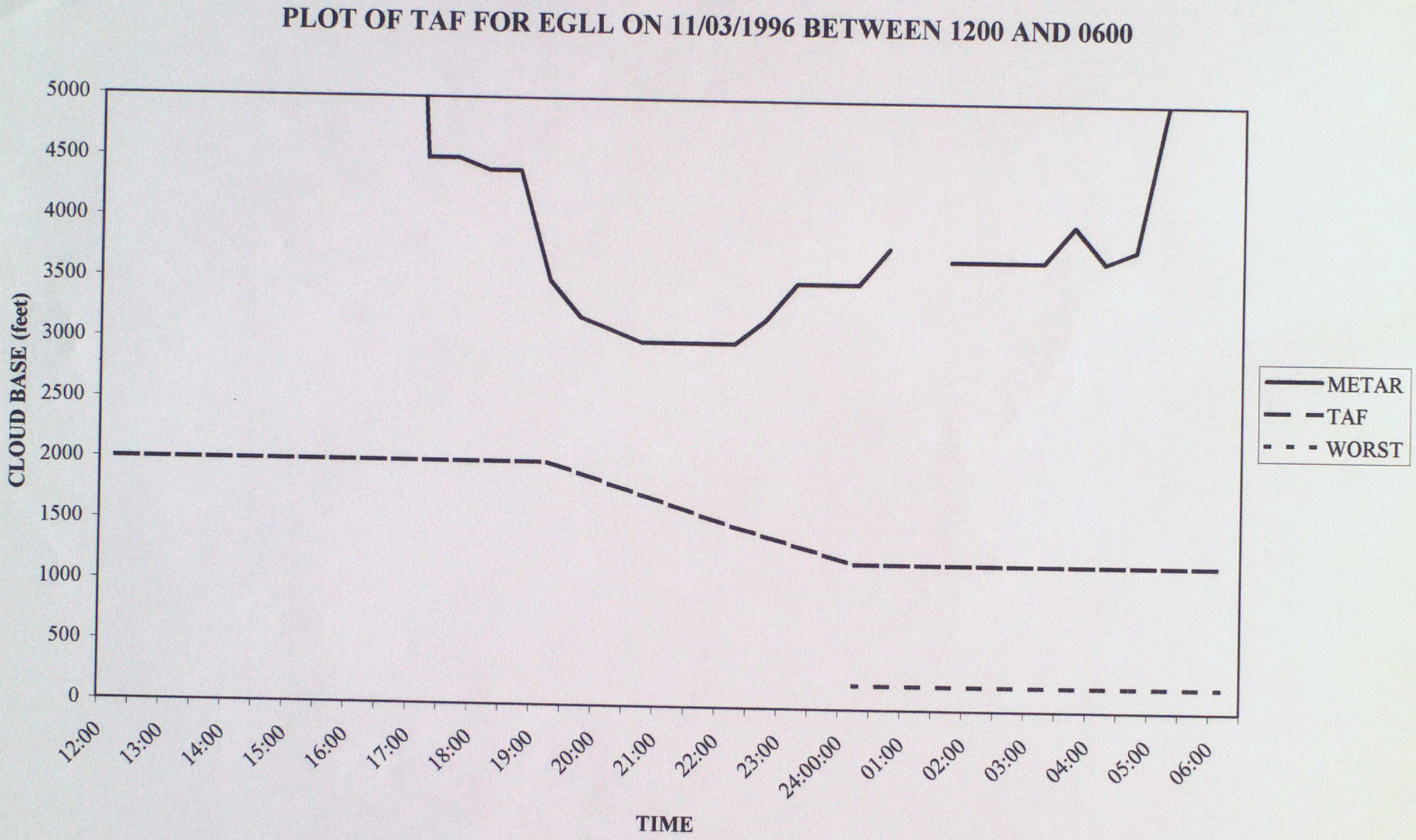


Figure 2


PLOT OF TAF FOR EGLL ON 11/03/1996 BETWEEN 1200 AND 0600
CLOUD BASE (feet)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00:00
01:00
02:00
03:00
04:00
05:00
06:00
TIME
METAR
TAF
WORST